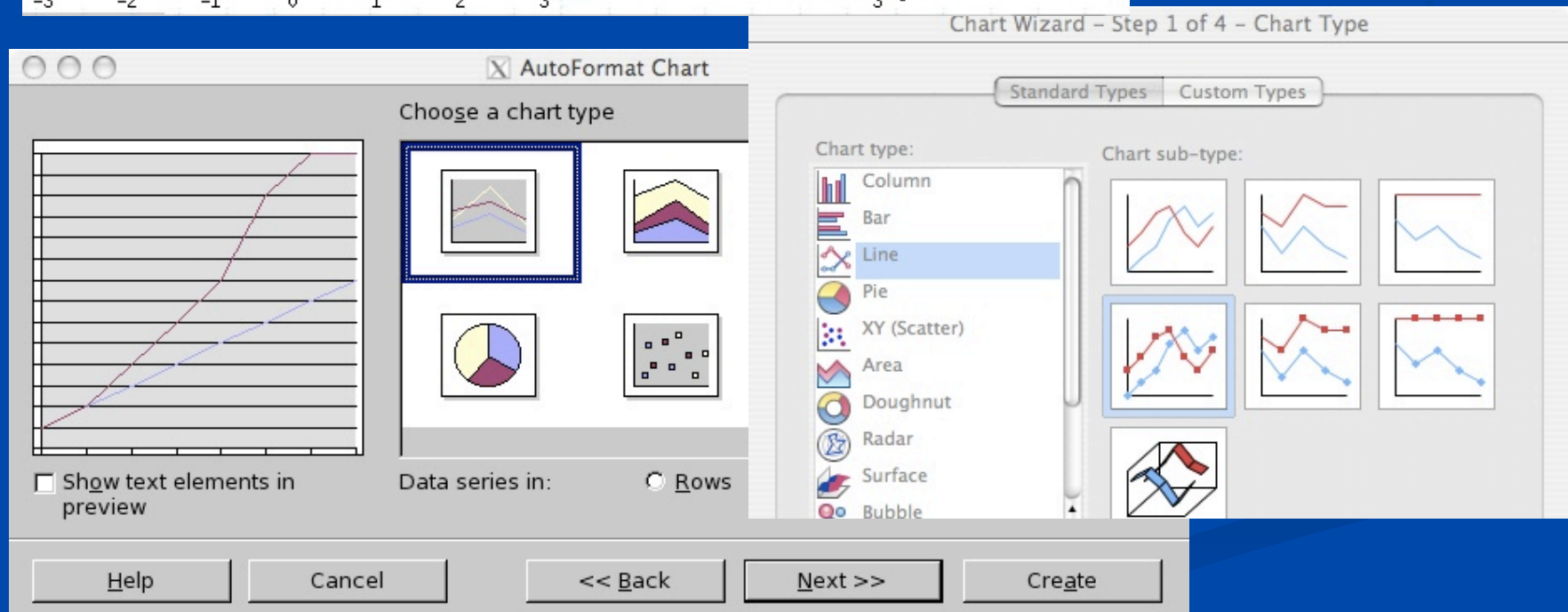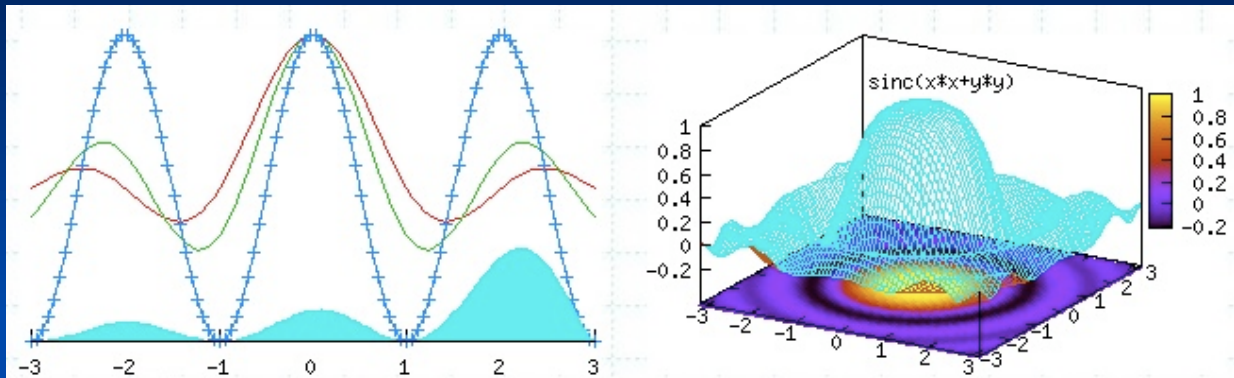# Trivial Data Analysis for Geant4

Geant4 v9.4

Joseph Perl, SLAC

Simple Analysis This Week

- Geant4 does not attempt to provide its own data analysis tools, focusing instead on its central mission as a simulation toolkit.

- The Geant4 user is expected to provide her own code to output results to an appropriate analysis format.

- Like Geant4 itself, this present tutorial is focused on the physics, so we are just using the simplest possible output format here, comma-separated values (.csv files)

- The resulting files can be analyzed by tools such as:
    - Gnuplot
    - Excel
    - OpenOffice

- Though we will not be using them in this present tutorial, information is available through the Geant4 web site on how to work with more advanced data analysis tools such as Root or the AIDA-compliant tools, PI, JAS3 and OpenScientist. I'll provide a few links to these more advanced tools in this talk, but will not go into any detailed instructions.

Gnuplot

- "**Gnuplot** is a **portable** command-line driven interactive data and function plotting utility for UNIX, IBM OS/2, MS Windows, DOS, Macintosh, VMS, Atari and many other platforms."

- "The software is copyrighted but freely distributed (i.e., you don't have to pay for it)."

- http://www.gnuplot.info/
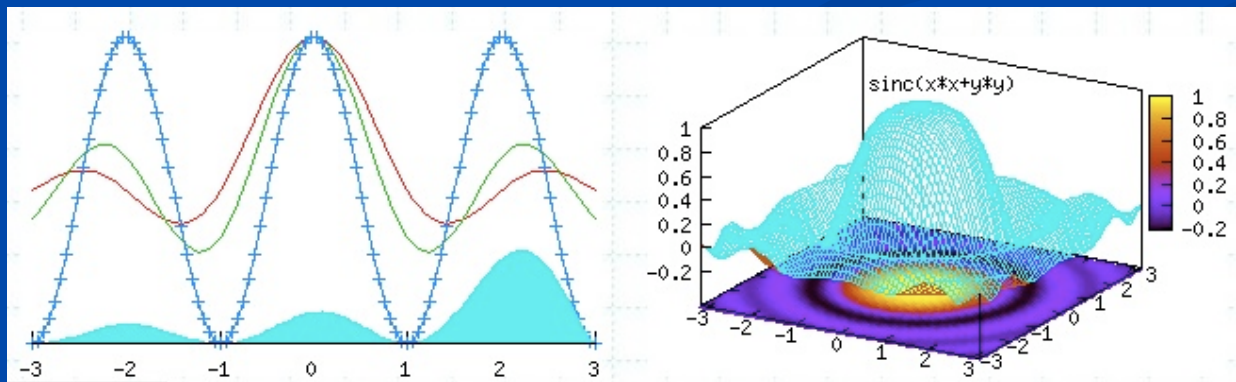
Plotting Data from a .csv File in Gnuplot

- **plot mydata.csv**


- **(that's all you need)**

Excel

- **Comes from a small company called MicroSoft.**
- **Part of Microsoft Office.**

Importing Data from a .csv File Into Excel

- From the "Data" menu, select "Get External Data"…"Import Text File…"
  - Select the file
  - The Text Import Wizard will come up
  - Check the "Delimited" box
  - Hit "Next"
  - Check the "Comma" box
  - The bottom part of the Wizard should now show your data nicely separated into appropriate columns.
  - Hit "Finish"
  - You will see a dialog titled "Import Data" which will ask where to put the data. Accept the defaults:
    - Existing worksheet:
    - =A1
  - Hit "OK"
- The data should now show up in the spreadsheet.
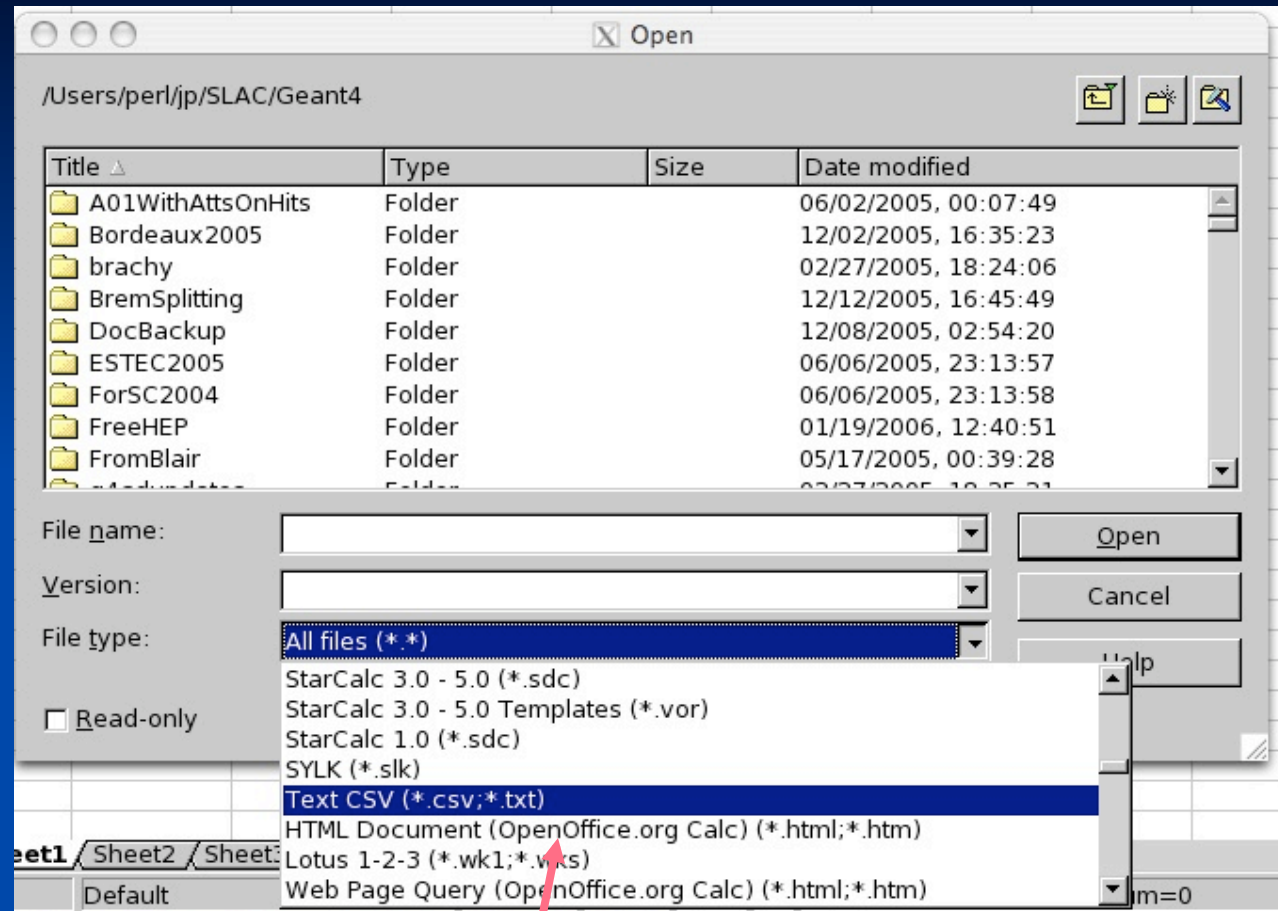
Plotting with Excel

- Now that the data is in the spreadsheet, you can plot it as follows:
    - Select at least one item in the filled data area.
    - From the "Insert" menu, select "Chart…"
    - Select Chart type: "Line"
    - Hit "Finish"
    - You're done
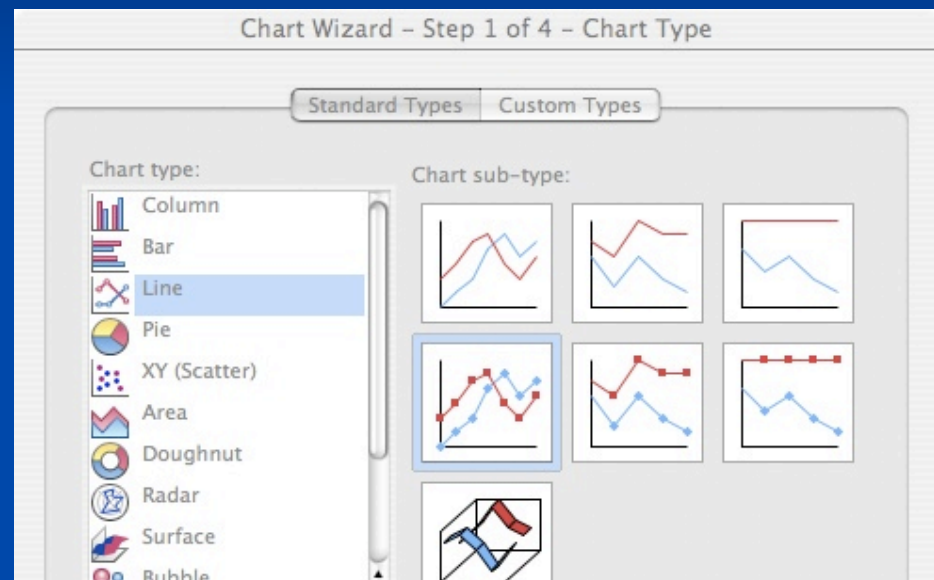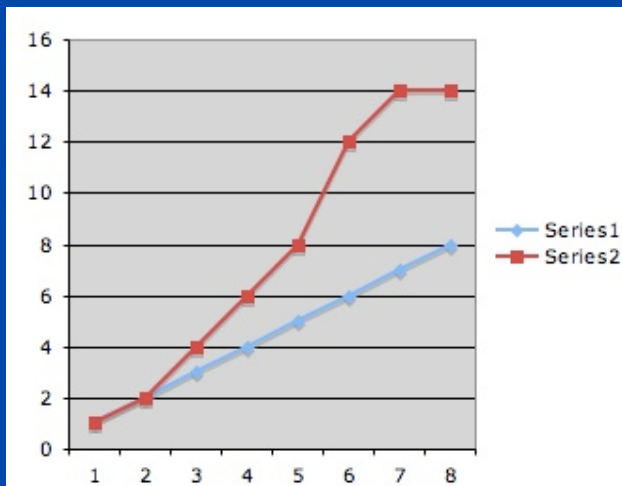
OpenOffice

- OpenOffice.org is a <u>multiplatform</u> and <u>multilingual</u> <u>office suite</u> and an <u>open-source</u> project.

- Compatible with all other major office suites, the product is free to download, use, and distribute.

- http://www.openoffice.org/

Importing Data from a .csv File Into OpenOffice

- From the "File" menu, select "Open…"
    - In the "File type" box, select "Text CSV"
      Note that this is NOT the same as just "Text"
   - Then select your file

Importing Data from a .csv File Into OpenOffice

- Once you select your file:
    - The Text Import dialog will come up
    - Check the "Comma" box
    - The bottom part of the dialog should now show your data nicely separated into appropriate columns.
    - Hit "OK"
- The data should now show up in the spreadsheet.
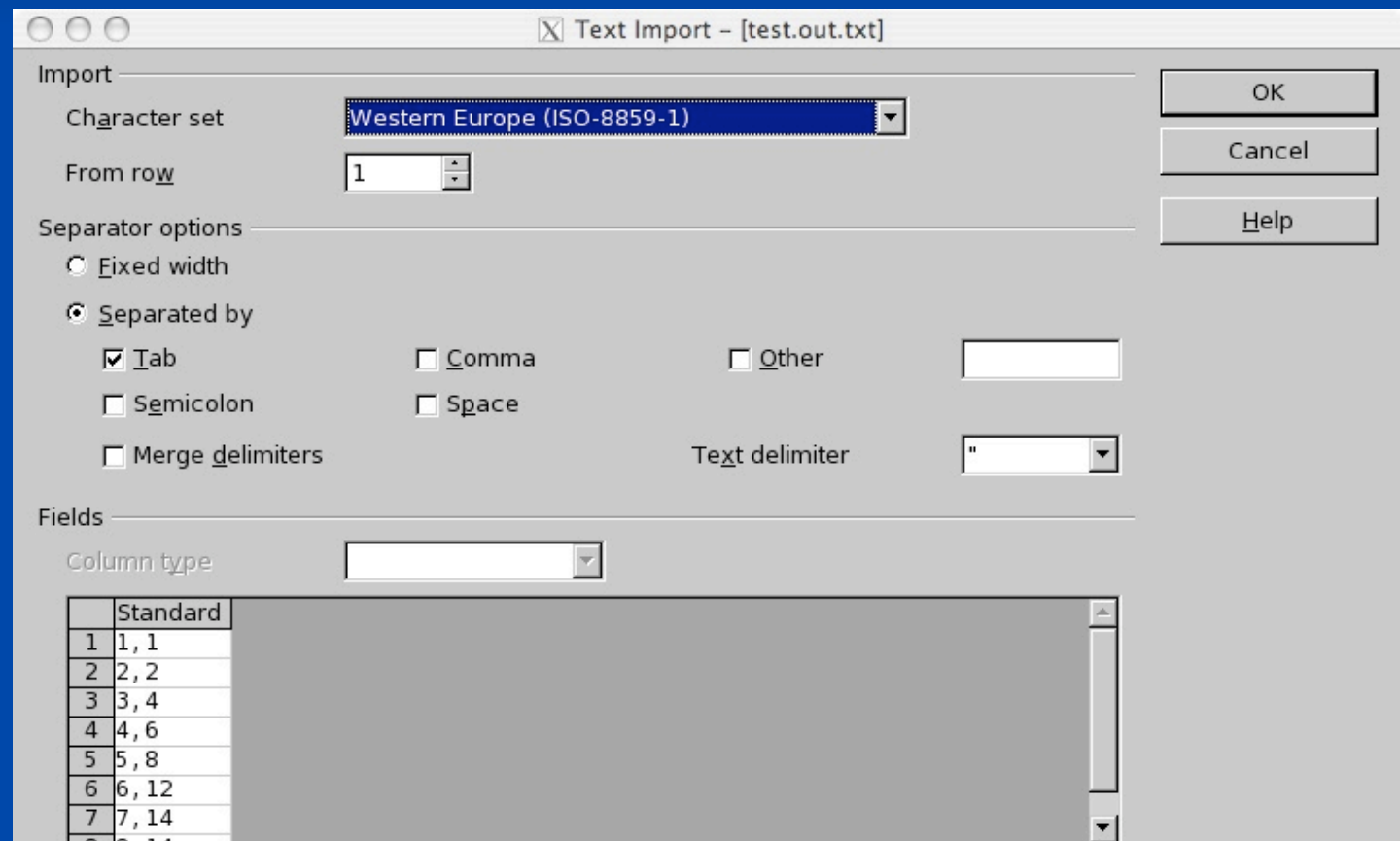
Plotting with OpenOffice

- Now that the data is in the spreadsheet, you can plot it as follows:
    - Select at least one item in the filled data area.
    - From the "Insert" menu, select "Chart…"
    - The defaults should be fine
    - Hit "Next"

    - Select the icon for "Line" chart
    - Hit "Create"
    - You're done
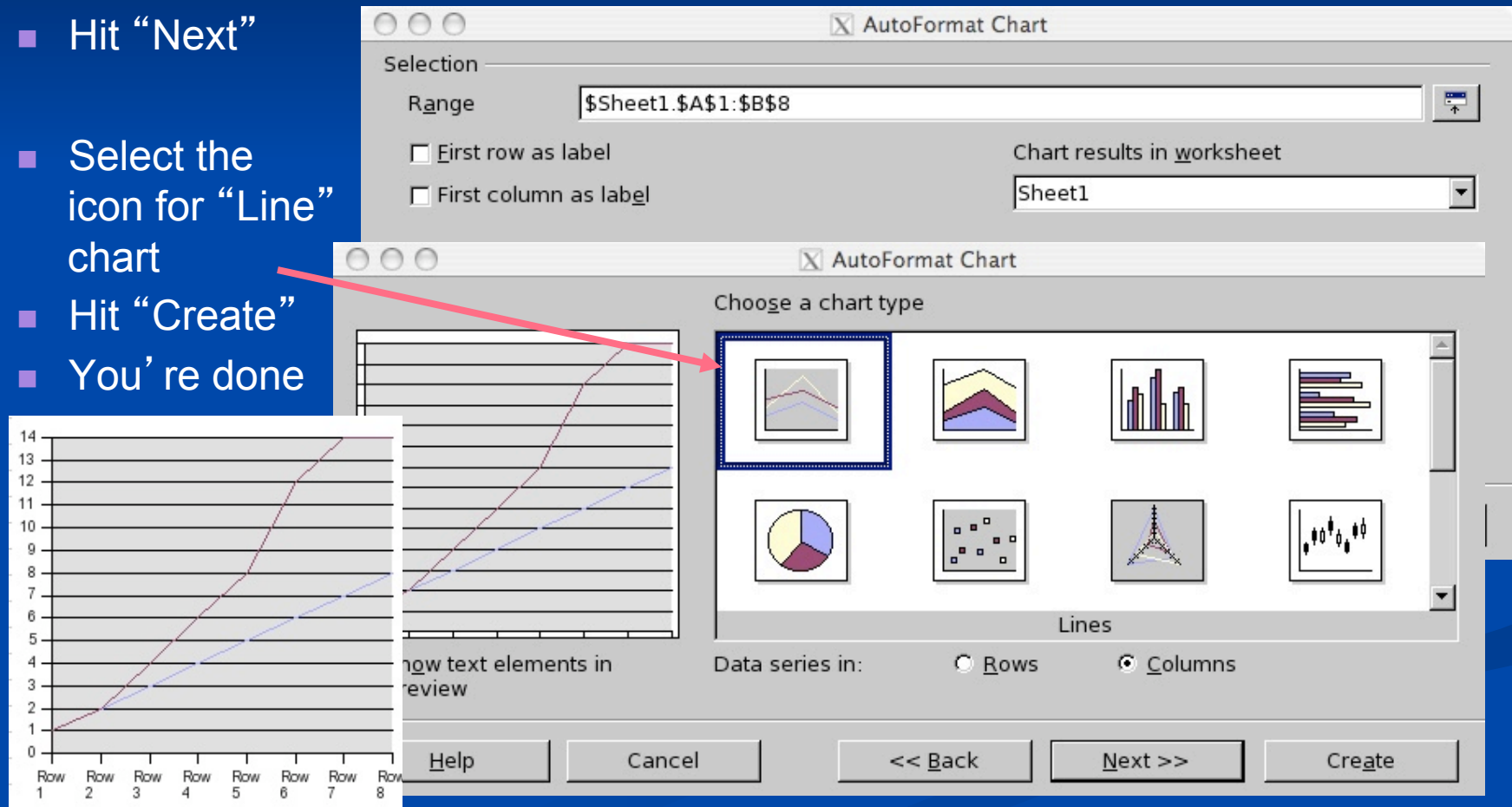
Pointers to More Advanced Data Analysis Options

- While the Geant4 collaboration does not maintain any data analysis system, many data analysis tool developers have interfaced their systems to Geant4 and each of the following has an active Geant4 user community.
- A good way to get started thinking about any of these is to look in the Geant4 Analysis Forum:
  - http://geant4-hn.slac.stanford.edu:5090/HyperNews/public/get/analysis.html

ROOT

- ROOT is an Object Oriented Data Analysis Framework.
- It is heavily used in High Energy Physics.
- Freely available.

- http://root.cern.ch/

AIDA

- Analysis Interface for Data Analysis
- AIDA is an interface standard used by several advanced data analysis tools. It provides a single standard way to create your data
  - Commands to instantiate an nTuple
  - Commands to fill an nTuple
  - Commands to instantiate a Histogram
  - Commands to fill a Histogram
- Depending on which AIDA-complaint tool you link in to Geant4, these commands will one or the other analysis tool
- You can switch from one AIDA-compliant tool to another without having to change how you book and fill your histograms.
  - http://aida.freehep.org/

The Three AIDA-Compliant Analysis Systems

- OpenScientist
  - http://openscientist.lal.in2p3.fr/
  - C++

- iAIDA
  - Refactored from a CERN LCG Application called PI
  - http://iaida.dynalias.net/Intro.html
  - C++ and xmgrace

- JAS3
  - http://jas.freehep.org/jas3/
  - Java

OpenScientist Pages Provide Excellent General Instructions on Using AIDA with Geant4

http://openscientist.lal.in2p3.fr/

OpenScientist

- Introduction
- Download and run
- Build from source
- The survival kit
- Newcomer ?

- osc-plot
- First AIDA program
- AIDA and Geant4
- osc-g4-vis
- osc-gui-viewer
- osc-gui-server
- osc-paw
- osc-new-app
- Python
- obuild

- AIDA, G4 under Windows

Introduction

OpenScientist is an integration of open source products working together to do scientific visualization and data analysis, in particular for high energy physics (HEP).

(OpenScientist is definitely not one million lines of intricated and unnecessary complicated home made code reinventing everything).

Ask for the programs !

The distribution comes with the osc-plot program that permits to visualize generic common analysis data as histograms, tuples, functions, cloud of points that are stored in file at various formats as plain ascii, aida XML, HDF5, old CERN/hbook and (already old) new CERN/root format. The osc-plot program permits to do interactive manipulations over these kind of data through dedicated GUI (Graphical User Interface) palettes. Someone can do also interactive fitting on them.

From the 16.8, comes also the osc-g4-vis program that permits to instrument in a swift some of the Geant4 examples and then permits to bring high level GUI and visualization to a Geant4 application.

Beside these, there is also the osc-gui-viewer that permits to view a GUI described in files at the XML .onx format. We attempt also to have some compatibility to the HEP past by having the osc-paw program.

Using AIDA with Geant4

OpenScientist

- Introduction
- Download and run
- Build from source
- The survival kit
- Newcomer ?

- osc-plot
- First AIDA program
- AIDA and Geant4
- osc-g4-vis
- osc-gui-viewer
- osc-gui-server
- osc-paw
- osc-new-app
- Python
- obuild

- AIDA, G4 under Windows
- AIDA and CERN-ROOT

- Demos

Before embarquing in connecting OpenScientist/AIDA with your Geant4 application, we advise to write first a pure AIDA program emulating the kind of statistical data you want to use and, if working with files, to check that the implementation actually supports the desired file format.

See the **OpenScientist as an AIDA implementation** section on how to create and run such program.

When done you can proceed by doing the same within your own Geant4 code. To compile and link with AIDA you have to arrange your build system to increment the compilation and link flags by using what is returned by :

```
aida-config --incs
aida-config --libs
```

(The best is to arrange to use a "backquoting" of the two upper lines).

If you have clone one of the Geant4 example and then if you work with the Geant4 GNUmakefile logic, then arrange to have in your main GNUmakefile :

```
include $(G4INSTALL)/config/binmake.gmk
CPPFLAGS += `aida-config --incs`
ANALYSISLIBS += `aida-config --libs`
```

OpenScientist

AIDA with Geant4 under Windows

Geant4 people promotes CYGWIN to work with Geant4.

But you have the choice to build and work with g++ or with VisualC++ (the CL.exe compiler).

Working with g++

If working with g++ (the default compiler under CYGWIN) (then having a G4SYSTEM set to WIN32-g++), you have to work with a CYGWIN/gcc osc_batch binary kit. That is to say a kit of the form :

```
osc_batch-<version>-CYGWIN-<processor>-gcc_<version>.zip
```

After unzipping, the way to work with the kit is similar to the way to work with a UNIX kit. You have to execute the "./install" once to enforce the installation paths in the setup scripts, and then "source setup" each time you want to use the kit. Be sure that the :

```
$ aida-config --incs
$ aida-config --libs
```

returns a syntax that is a g++ syntax, that is to say some -I, -L followed with a path having / as separator.

Working with VisualC++

If working with VisualC++ (G4SYSTEM being set to WIN32-VC), the way to proceed is a little bit different. You have to work with a Windows_NT/cl osc_batch binary kit. That is to say a kit of the form :

Use Whatever Analysis Tool You Like

- Geant4 does not attempt to provide its own data analysis tools, focusing instead on its central mission as a simulation toolkit.

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